PB85-193332

Macroinvertebrate Distribution among Some Southern California Vernal Pools

Woodward-Clyde Systems Div., San Diego, CA

Prepared for

Corvallis Environmental Research Lab., OR

1985

U.S. Department of Commerce
National Technical Information Service

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA/600/D-85/080	2. PB85-193332
4. TITLE AND SUBTITLE: Macroinvertebrate Distribution Among Some Southern California Vernal Pools	5. REPORT DATE: 1985 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S): Betty Dehoney and Donald M. LaVigne	8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Woodward-Clyde Systems Division 3489 Kurtz Street San Diego, CA	10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS: Environmental Research Laboratory Office of Research and Development - U.S. EPA 200 SW 35th Street Corvallis, Oregon 97333	13. TYPE OF REPORT AND PERIOD COVERED 14. SPONSORING AGENCY CODE: EPA/600/02
15. SUPPLEMENTARY NOTES: Project Officer: William Sanville	

16. ABSTRACT

Invertebrates were collected from eight vernal pools located on Otay Mesa, San Diego County, California during March and April 1980. Two distinct pool habitats were found. Pools with a maximum depth greater than or equal to 14 cm retained water for a period of 1.5 to 3 weeks longer than the shallow pool series. A distinct species population appeared to be associated with each pool type. Three groups of species were noted, one group widely distributed among most of the pools, a second group generally restricted to the shallow pools. Possible explanations for this distribution include predator-prey interactions, life history phenomena, and water chemistry parameters.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT: Release to Public	19. SECURITY CLASS *(This Report)*: Unclassified	21. NO. OF PAGES: 8
	20. SECURITY CLASS *(This page)*: Unclassified	22. PRICE

EPA Form 2220-1 (9-73)

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

EPA/600/D-85/080
1985

MACROINVERTEBRATE DISTRIBUTION AMONG SOME SOUTHERN CALIFORNIA VERNAL POOLS

Betty Dehoney[1] and Donald M. LaVigne[2]
Woodward-Clyde Systems Division, 3489 Kurtz Street, San Diego, CA

Abstract. Invertebrates were collected from eight vernal pools located on Otay Mesa, San Diego County, California during March and April 1980. Two distinct pool habitats were found. Pools with a maximum depth ≤14 cm retained water for a period of 1.5 to 3 weeks longer than the shallow pool series. A distinct species population appeared to be associated with each pool type. Three groups of species were noted, one group widely distributed among most of the pools, a second group generally restricted to deeper pools, and the third group generally restricted to the shallow pools. Possible explanations for this distribution include predator-prey interactions, life history phenomena, and water chemistry parameters.

INTRODUCTION

The intermittent nature of the vernal pool habitat prohibits the presence of fish, but a diverse fauna does exist. This fauna can be characterized as one generally lacking protection against large predators, able to tolerate extremes of temperature and other physical factors, resistant to desiccation, and equipped with extraordinary dispersal mechanisms (Kerster 1976). Bishop (1967) reported that animals inhabiting vernal pools may be adapted to their environment in at least one of three ways: by having good dispersal powers; by being able to survive the dry periods in dormant stages; or by making rapid use of favorable conditions when they occur. Insects have good dispersal powers and adults can leave the pond when conditions become unfavorable. Zooplankton have high reproductive potentials which allow them to take advantage of favorable conditions when they occur, and have a dormant stage, such as eggs or cysts, that can survive unfavorable conditions.

Distribution of zooplankton among vernal pools in San Diego County has been reported to be dependent upon the duration of standing water and dispersal mechanisms (Zedler and Ebert 1979). Life history characteristics are also important in determining the occurrence of invertebrates in various pools. For example, Zedler and Ebert (1979) found that cladocerans, which require a period of time to develop their resting eggs, are normally absent in short-lived pools, whereas copepods, which are capable of forming drought resistant cysts, are present in almost all pool types.

[1,2]6046 Rancho Mission Road, San Diego, California 92108; and Data Systems Marketing, 5710 Ruffin Road, San Diego, California 92123, respectively.

Zedler and Ebert (1979) reported that the number of species present in a pool was variable, but generally was correlated with physical conditions (such as pool size and water depth) rather than water chemistry parameters (such as pH and conductivity). An increase in the number of species was associated with an increase in pool surface area and average water depth. Frequency of pool drying was another factor that affected the number of species present.

In this study, macroninvertebrates were collected from vernal pools located on Otay Mesa, San Diego County, California (R1E, T18S). Water depth and retention time varied among the pools. Species presence in each pool was analyzed to examine differences in species composition among the pools, and to explore some possible reasons for such differences.

METHODS

Qualitative plankton (March 1980) and dip net (March and April 1980) samples were collected from exist vernal pools on Otay Mesa in San Diego County, California (Fig. 1). Several field trips were made to note the presence and depth of water in each pool. Samples were preserved in 70% ETOH until laboratory processing. Invertebrates were identified using Usinger (1956), Johannsen (1969), Merritt and Cummins (1978), and Pennak (1978).

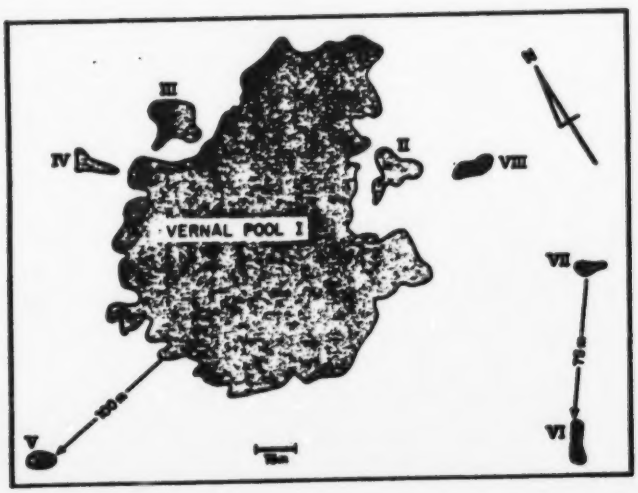

Figure 1. Relative size and location of eight vernal pools sampled in March 1980.

Taxon presence-absence in each pool was used to cluster pools with similar faunas. A distance matrix was constructed using the Bray-Curtis algorithm (Bray and Curtis 1956) and dendrograms were constructed using an agglomerative hierarchical classification technique with a flexible sorting strategy (Lance and Williams 1967, Sneath and Sokal 1973, Clifford and Stevenson 1975, Smith 1976). The flexible sorting coefficient (β) was set at -0.25 (Clifford and Stevenson 1975). Smith (1976) provides a discussion of the various sorting strategies and justification of the classification methods used. The dendrogram groups were used as a basis for examining microinvertebrate distribution patterns among pools.

RESULTS

The distribution of the invertebrates, maximum water depth reported and the last date that water was reported in each of the eight vernal pools are presented in Table 1. Chironomidae, Agabus sp. and Copelatus chevrolati renovatus were widely distributed throughout most of the pools. Callibaetis sp., Anax junius, Daphnia sp., Sigara sp., and ostracods were primarily found in the pools with maximum depths over 14 cm that retained water into April. Copepods were restricted to pools with maximum depths less than 12 cm that retained water only through the middle of March. Chaoborus sp. was found in several pools with maximum depths ranging from 5 to 20.5 cm. Other dpiterans did not appear to be restricted to any specific habitat type.

A dendrogram representing similarities in pool preference among species is presented in Figure 2A. Three major groups are apparent. The first group includes Agabus sp., Copelatus chevrolati renovatus, Chironomidae, and Anthomyiidae. The distribution of these organisms was not limited by duration or depth of water (Table 1). The first three organisms of the group were found in most of the pools examined; Anthomyiidae were found in one deep and one shallow pool. The second group includes Cyclopoidae, Tipulidae, and Tropisternus lateralis; these species were found in the shallow pools. The third group consisted of Anax sp., Callibaetis sp., Chaoborus spl., Daphnia sp., Ostracoda, and Sigara sp. Most of these species were restricted to deeper pools, although Chaoborus sp. was also found in the shallowest pool.

Significant differences in species composition exist among the pools studied. The number of species ranged from one in pool VII to nine in pool III. A dendrogram showing similarities in species composition among the pools is presented in Figure 2B pools I, II, III, and IV are grouped together, with pools V, VI, and VIII forming a second group in terms of species composition.

Table 1. Invertebrates collected from Otay Mesa vernal pools, with maximum water depth and last date pools retained water.

TAXA	I	II	III	IV	V	VI	VII	VIII
Diptera								
Chironomidae	X	X	X		X	X		
Tipulidae						X		
Anthomyiidae		X				X		
Culicidae								
Chaoborinae								
Chaoborus sp.		X	X	X		X		
Coleoptera								
Dytiscidae								
Agabus sp.	X	X	X	X	X	X	X	X
Copelatus chevrolati	X	X	X	X	X	X		X
Hydrophilidae								
Tropisternus lateralis								X
Ephemeroptera								
Baetidae								
Callibaetis sp.	X	X	X	X				
Odonata								
Anisopetera								
Aeshnidae								
Anax junius	X	X	X					
Hemiptera								
Corixidae								
Sigara sp.			X	X				
Crustaceae								
Cladocera								
Daphnia sp.		X	X	X				
Ostracoda	X		X	X				
Copepoda								
Cyclopoidae					X	X	X	X
Maximum water depth (cm)	15.0	15.0	20.5	14.0	12.0	5.0	6.0	7.5
Last date with water	9 Apr	2 Apr	9 Apr	2 Apr	17 Mar	16 Mar	15 Mar	17 Mar

DISCUSSION

Vernal pools on Otay Mesa were found to have distinct faunas. The deeper pools in the study had faunas that were most closely related to one another than to the faunas of the shallow pools. The presence and diversity of zooplankton was found to be dependent upon the duration of water in a vernal pool (Zedler and Ebert 1979). It appears that the duration of water affects the diversity and kinds of other invertebrates as well. Zedler and Ebert (1979) also reported that cladocerans, which have long reproductive cycles when compared to copeopods, were generally found only in pools retaining water longer than

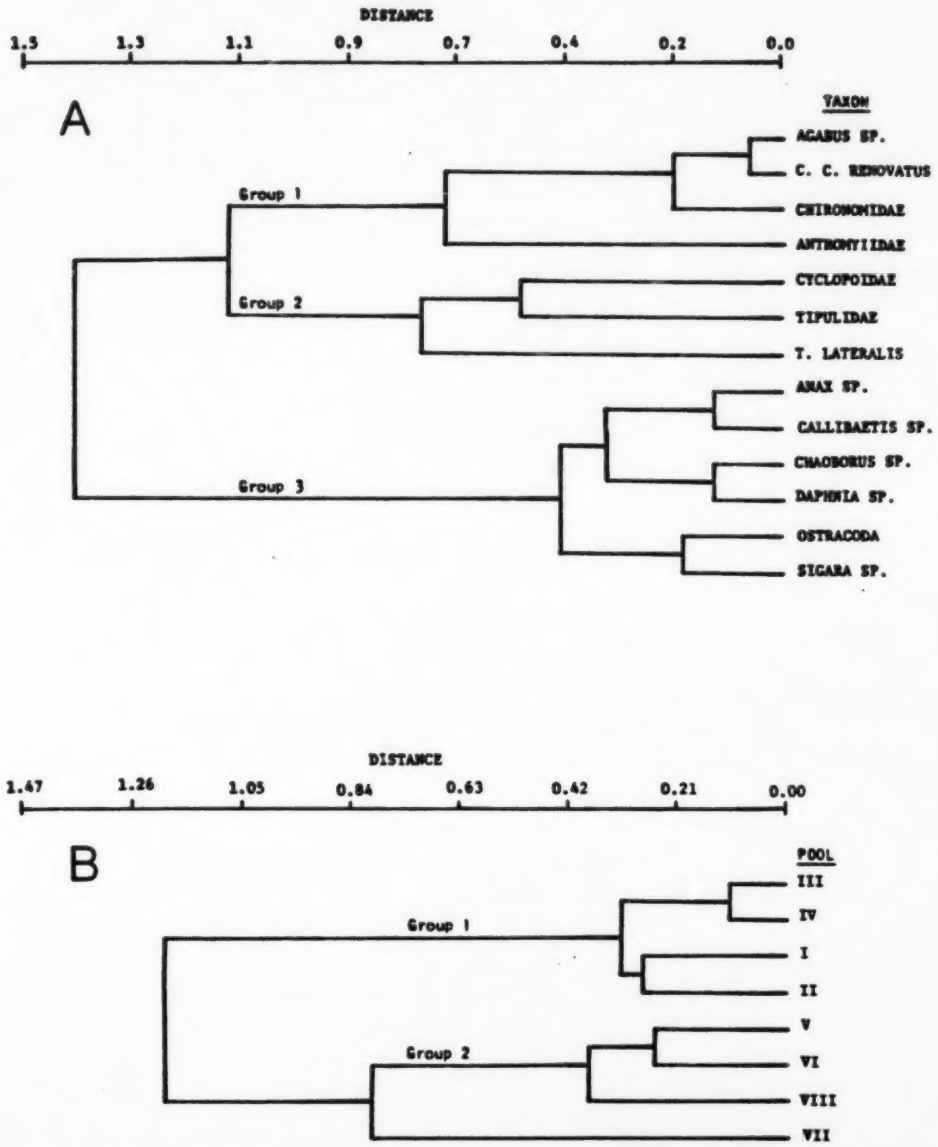

Figure 2. (A) Dendrogram showing similarities among distribution patterns of taxa; (B) Dendrogram showing similarities among pools in terms of their community composition. See text for additional explanation.

pools containing copepods but not cladocerans. In the present study cladocerans were found in pools with maximum recorded depths of $\geq$ 14 cm, while copepods were found in pools with a maximum depth of $\leq$ 12 cm.

The deeper Otay Mesa pools were wet on an average of 2.5 to 3 weeks longer than the shallow pools. The association of pool depth and duration with species presence suggests that two distinct macroinvertebrate communities, dependent on water depth and/or dura-

tion, exist in the study pools. The dendrogram in Figure 2A illustrates the existence of separate macroinvertebrate communities. The species contained in group 2 of the dendrogram are all found only in shallow, short-lived pools and can all be considered members of one community. With one exception (Chaoborus sp.), the species in group 3 of the dendrogram are all found only in deep, long-lasting pools and can be considered members of a second community. Chaoborus sp., included as a member of the deep water community, was also found once in a shallow pool. This could easily be the result of involuntary emigration from a deep pool on the feathers of a bird or the fur of an animal passing between the pools. Species group 2 contains species found throughout all the pools and considered members of both communities.

These species distribution patterns can be attributed to several factors: (1) predator-prey interactions, (2) life history phenomena and, (3) water chemistry parameters. Each species group (Figure 2A) contained one or two predators; the remaining organisms were either filter feeders, detritivores or herbivores. Organisms considered primarily as predators include Agabus sp., Copelatus chevrolati renovatus, Tropisternus lateralis, Anax sp., and Sigara sp.

Life history differences between seasonal timing of reproduction and length of reproduction could affect the distribution of some species. The length of reproduction has been found to affect the distribution of cladocerans and copepods (Zedler and Ebert 1979). Since most of the other organisms are insects that have terrestrial adult stage, the seasonal timing of egg laying would affect the distribution of the organisms in the pools. If the adults lay eggs after the shallow pools are dry, their distribution would be limited to the deeper pools. No data have been found noting the time for insect emergence in vernal pools.

ACKNOWLEDGEMENTS

This study was part of a larger project that investigated the role and function of small isolated wetlands and intermittent streams, nationwide. Federal funding was provided by the U.S. Environmental Protection Agency, Contract No. 68-03-2901 to Dr. Keith B. Macdonald, Woodward-Clyde Consultants, Principal Investigator. The authors wish to acknowledge Mr. Tim Cass for his help in formulating the ideas presented here.

REFERENCES CITED

Bishop, J. A. 1967. Some adaptations of Limnadia stanleyana King (Crustacea: Brachiopoda: Conchostraca) to a temporary freshwater environment. J. Animal Ecol. 36:599-609.

Bray, J. R. and J. T. Curtis. 1957. An ordination of the upland forest communities of southern Wisconsin. Ecol. Monogr. 27:325-349.

Clifford, H. T. and W. Stephenson. 1975. An Introduction to Numerical Classification. Sab Francisco: Academic Press, 299 pp.

Johannsen, O. A. 1969. Aquatic Diptera. Entomological Reprint Specialists. Los Angeles.

Kerster, H. W. 1976. Vernal pool fauna - A commentary. In: S. Jain (ed.). Vernal Pools: Their Ecology and Conservation. Inst. of Ecol. Publ. 9:86.

Lance, G. N. and W. T. Williams. 1967. A general theory of classificatory sorting strategies. I. Hierarchical system. Computer Journal 9:373-380.

Merritt, R. W. and K. W. Cummins. 1978. An Introduction to the Aquatic Insects of North America. Kendall/Hunt Publishing Co., Dubuque, Iowa.

Pennak, R. W. 1978. Fresh-water Invertebrates of the United States, 2nd edition. The Ronald Press Co. N.Y.

Smith, R. W. 1976. Numerical Analysis of Ecological Survey Data: Ph.D. thesis, University of Southern California.

Sneath, P. A. and R. R. Sokal. 1973. Numerical Taxonomy. San Francisco: W. H. Freeman and Co., 573 pp.

Usinger, R. L. 1956. Aquatic insects of California. University of California Press. Berkeley and Los Angeles.

Zedler, P. H. and T. A. Ebert. 1979. A survey of vernal pools of Kearney Mesa, San Diego, CA., Spring 1979. CALTRANS Grant 06309 Progress Report, San Diego, CA.

NOTICE

This document has been reviewed in accordance with U.S. Environmental Protection Agency policy and approved for publication. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.